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Goddard View

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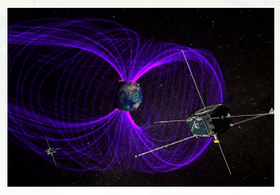
THE WEEKLY

Rain on the Sun?
A moderately powerful solar flare exploded on the sun's lower right limb, sending out light and radiation. Next came a CME, which shot off to the right out into space. And then, the sun treated viewers to one of its dazzling magnetic displays—a phenomenon known as coronal rain. SDO captured it all. Click on the image to see more.

Webb Telescope Components Meet "Big Red"
"Big Red" is the nickname for a small chamber that helps ensure equipment can withstand very cold temperatures that would be experienced in space. It is being used at Goddard as a vital part of the testing program to verify that the science cameras and spectrographs will function as planned. To learn more about the Webb Telescope, click on the picture.

Asteroid DA14
Dante Lauretta, principal investigator of the OSIRIS-REx mission from the University of Arizona, discusses the February 2013 fly-by of asteroid 2012 DA14. Scheduled for launch in 2016, OSIRIS-REx will journey to a different asteroid (1999 RQ36) and study it for several years. Click on the image to watch.

Six Years in Space for THEMIS
Earth is surrounded by a giant magnetic bubble, called the magnetosphere. Over six years in space, five spacecraft from the THEMIS mission have helped map out this area and improve our ability to predict dynamic space weather events – events that at their worst can impact satellites in space. Click the image to learn more.



On the cover: A United Launch Alliance Atlas V rocket with the LDCM spacecraft onboard lifts off the launch pad at Vandenberg Air Force Base in California on Feb. 11, 2013.

Photo credit: United Launch Alliance.

GoddardView

Goddard View is an official publication of NASA's Goddard Space Flight Center. *Goddard View* showcases people and achievements in the Goddard community that support Goddard's mission to explore, discover, and understand our dynamic universe. *Goddard View* is published weekly by the Office of Communications.

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NASA LAUNCHES NEW EARTH OBSERVATION SATELLITE

By: Steve Cole, George Diller and Rani Gran

NASA's Landsat Data Continuity Mission (LDCM) roared into space at 1:02 p.m. EST on Monday, February 11 aboard an Atlas V rocket from Vandenberg Air Force Base in California.

"Landsat is a centerpiece of NASA's Earth Science program, and today's successful launch will extend the longest continuous data record of Earth's surface as seen from space," NASA Administrator Charles Bolden said. "This data is a key tool for monitoring climate change and has led to the improvement of human and biodiversity health, energy and water management, urban planning, disaster recovery and agriculture monitoring—all resulting in incalculable benefits to the U.S. and world economy."

LDCM will go through a check-out phase for the next three months. Afterward, operational control will be transferred to NASA's mission partner, the Department of the Interior's U.S. Geological Survey (USGS), and the satellite will be renamed Landsat 8. Data will be archived and distributed free over the Internet from the Earth Resources and Science (EROS) center in Sioux Falls, S.D.

LDCM is the eighth in the Landsat series of satellites that have been continuously observing Earth's land surfaces since 1972. The use of Landsat data been transformed in recent years by advancements in computing power and the decision by USGS to allow free online access to the information. This revolution has allowed scientists to detect changes over time to our planet and has enabled a host of applications based on Landsat measurements to be developed by researchers, the private sector, and state, local, and tribal governments.

LDCM continues that legacy with more and better observations. The spacecraft carries two instruments, the Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). The measurements will be compatible with data from past Landsat satellites, but the LDCM instruments use advanced technology to improve reliability, sensitivity, and data quality.

"LDCM is the best Landsat satellite ever built," said Jim Irons, a LDCM project scientist at Goddard. "The technology will advance and improve the array of scientific investigations and resource management applications supported by Landsat images. I anticipate new knowledge and applications to emerge with an increasing demand for the data."

OLI will continue observations currently made by Landsat 7 in the visible, near infrared, and shortwave infrared portions of the electromagnetic spectrum. OLI's new design has fewer moving parts than instruments on previous Landsat satellites.

TIRS will collect data on heat emitted from Earth's surface in two thermal bands, as compared with a single thermal band on previous Landsat satellites. These thermal band observations are becoming increasingly vital to monitoring water consumption, especially in the arid western United States. ■

Above: At Vandenberg Air Force Base in California, the launch pad tower at SLC-3 is rolled back to reveal the United Launch Alliance Atlas-V rocket with the LDCM spacecraft onboard. Photo credit: NASA/Kim Shiflett

> "This is the first example of a printed part being made for a Goddard-managed flight project."

3-D PRINTING CREATES COMPLEX ASTRO-H COMPONENT

By: Lori J. Keesey

Neil Armstrong was the first man on the moon and Yuri Gagarin was the first in space. Though engineer David Robinson may not put himself in the same league as Armstrong or Gagarin, he, nonetheless, can say he was the first at Goddard to use 3-D laser printing to fabricate a complex instrument component for an upcoming astrophysics mission.

The additive manufacturing technology Robinson employed—a computer-operated device that literally prints a solid object from powdered metals—is called direct metal laser sintering (DMLS). With this technology, a part is built with a high-powered optic laser that melts and fuses metal powder in precise locations as indicated by a 3-D CAD model. Since the components are built layer by layer, it is possible to design internal features and passages that could not be cast or machined.

Working with Goddard technologist Steven Kenyon, who spent last year thoroughly evaluating the technology's practicality for spaceflight applications, Robinson helped develop with Goddard's Cryogenics Branch a titanium heat switch for the Adiabatic Demagnetization Refrigerator. The cooling system, advanced by Goddard technologist Peter Shirron, will keep the ultra-sensitive microcalorimeter detectors on Astro-H's Soft X-ray Spectrometer at a frosty -459.58 degrees Fahrenheit (.05 degrees above absolute zero).

Although Marshall Space Flight Center has purchased an additive-manufacturing machine to create rocket nozzles, this is the first example of a printed part being made for a Goddard-managed flight project, Robinson said. He originally built the heat switch as a demonstration unit; however, he may use it in the actual flight instrument should the baseline design unit run into difficulties.

The part showcases the benefits of laser printing, said Kenyon, who last August put Robinson in touch with the part's manufacturer, GPI Prototype and Manufacturing Services in Lake Bluff, Illinois.

Consisting of five nested shells inside a tube, the DMLS-produced heat switch is difficult and time consuming to create with standard machining processes, Robinson said. "Fabricating this part using conventional methods requires making five different-sized tubes and welding them together," he added. "I'd estimate that it would take about three months to receive this part and I'd expect to pay between $10,000-$20,000. But with this new printing process, the part cost only $1,200 and took two weeks for the finished part to get into my hands," Robinson said.

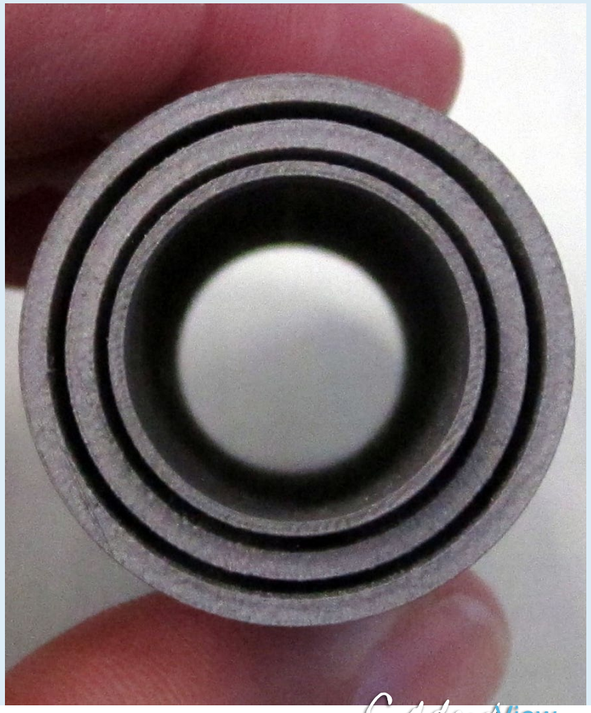
Kenyon's role in the fabrication of Goddard's first DMLS-produced part was in large part due to a study that he and his team carried out last year to investigate the technique's appropriateness for spaceflight applications. Kenyon became intrigued by the possibilities when he used the method to create a Modulated X-ray Source for an instrument Goddard scientist Keith Gendreau is developing for a possible flight on the International Space Station.

His investigation, funded by Goddard's Internal Research and Development (IRAD) program, included tests of various DMLS-produced specimens—tests that revealed that most samples met or exceeded the mechanical properties advertised for each material. Kenyon's IRAD-funded study also included the development of a manual that includes design rules and project examples.

"There isn't a large demand for producing parts using this process right now, but I think it's because people don't understand the process and its potential benefits," Kenyon said. "I do think there will be a demand in the future, though. This technique is the real deal. You can use these parts." ■

Opposite: Technologist Steven Kenyon, shown here with several components created with 3D laser printing, believes the fabrication technique is suitable for spaceflight instruments and expects interest to grow. Photo Credit: NASA/Goddard/Pat Izzo

Below: Goddard engineer David Robinson used 3-D laser printing to create this component for Astro-H—the first time Goddard has used the technique to create a part for a flight instrument.



LAUNCHING 101: FIRST BALLOONS, THEN ROCKETS

By: Laura Betz

Science writer Laura Betz shares her experiences assisting with weather balloons used to prepare for the recent launch of the Landsat Data Continuity Mission.

I'm standing in an isolated clearing at Vandenberg Air Force Base in California on February 11, 2013, holding an enormous weather balloon. Just as I'm about to let it go, it's tugging on my arm with four pounds of force.

"Ten seconds. Five. Release Lima 5."

As the balloon shoots up, I crane my head and watch it shrink away into the blue. It's sending critical data back to the ground that will help mission managers decide if the Atlas-V rocket on the pad nearby should be cleared to launch the Landsat Data Continuity Mission.

As it soars away from the surface, up to about 20 miles (30 kilometers) or more, the pressure is changing. As it does, the balloon goes from being the size of a large yoga ball to that of a school bus.

After the balloon launch, I help the base weather team input data in their office, a small three-roomed building filled with computer screens. When I met the team (see below) early on launch day, they had been releasing balloons for six hours already. As the 10 a.m. PST rocket launch nears, they release balloons every twenty minutes to make sure conditions are right. Richard Stedronsky, one of the meteorologists on the team, says that way the mission isn't taking any chances.

"We launch a lot of these balloons leading up to flight because everyone needs to know where the winds are, so they can account for worst-case scenario," he says. "Without these balloons, we wouldn't know how the winds are behaving throughout the atmosphere."

He says that monitoring wind shear—the rate at which wind speeds change from point to point—is essential to making sure the rocket gets to where it needs to go. This is especially important for high altitudes. "With the balloons, you know for sure. Yes, it's going to stay on trajectory. Or if something in the wind profile is changing, they can adjust the trajectory to get the payload into orbit," he says.

I am in the balloon shop, which is essentially a glorified shed that allows the weather team to fill up the balloons with helium without them blowing away. To the left of me is a "low-res balloon." It looks like a huge birthday balloon. To the right is a "high-res" balloon that looks like what I imagine would be any puppy's dream: a humongous spiky chew toy that floats.

Low-res balloons, often called synoptic balloons, are released all over the world for weather forecasting, often twice a day; they can expand as they travel up through the atmosphere. High-res balloons are made of plastic and have spikes on the side to increase their stability. To prevent them from expanding as they rise, they have a release valve. They also have shorter strings to make them more stable.

They blow up these balloons by laying them down on a netted table and connecting them to a helium hose. The hose connects to a truck stacked up with helium.

Then members of the launch weather team, like Stedronsky and Breea Lisko, fasten a radiosonde (a weather-sensing instrument that looks like a small box) and a parachute to help break the radiosonde's fall when the balloon inevitably bursts.

> "The team has to know this information to protect nearby areas from debris."

There's an antennae on the radiosonde; its transponder sends information back on a certain frequency. It comes back to the "antennae farm," a group of antennae outside the building that feeds it into a computer system in the office. Inside, the Automated Meteorological Profiling System gathers the temperature, dew point, wind speed and direction. The team ingests the data into the system then feeds it into another real-time system that shares it with the world.

Inside the range weather office, there's a whiteboard hanging up in the office with the weather information for the launch. Stedronsky points to it and tells me that it reads "whiskey-zero-eight-zero-three-one (WO8031)." They use Julian dates, not standard calendar dates.

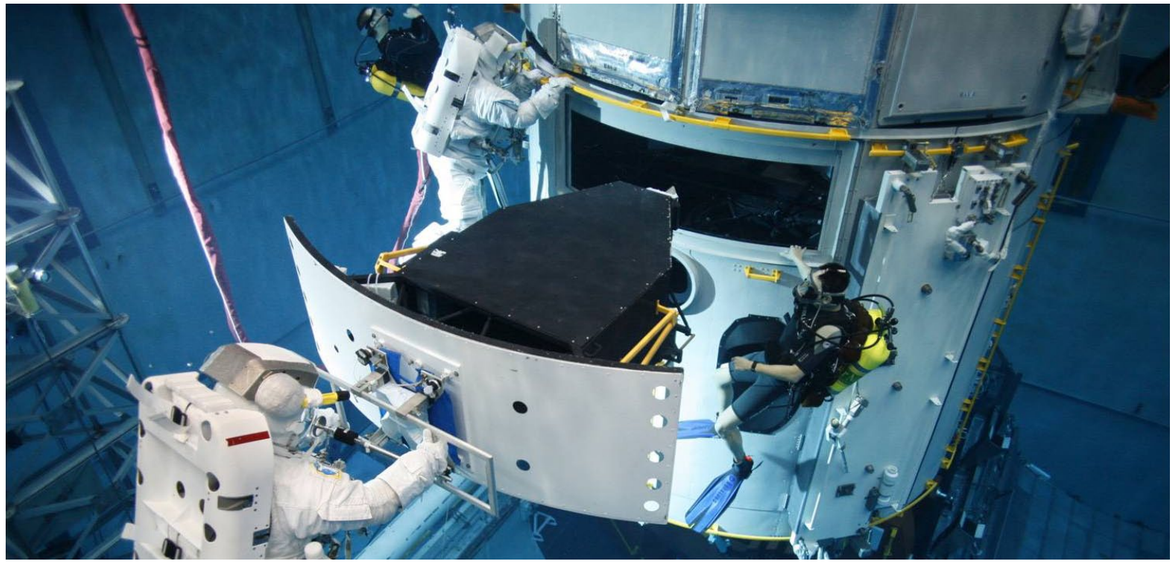
This information goes into the systems to initialize the conditions for the balloons. They will use these values to set a starting condition for the radiosondes. Right now, the winds are 1 to 10 knots, the temperature is 6.7 degrees Celsius (44.1 degrees Fahrenheit). The team puts that information into the computer so that the radiosonde takes that as the first data point for its observations and starts recording.

"How is this information important?" I ask.

"As far as these balloons go, if something were to go wrong with the rocket, we have the ability to determine that. If we have to terminate flight, the pieces would land where we want them to land," says Lisko. The team has to know this information to protect nearby areas from debris. "If something were to go wrong, there would be a lot of chemicals and bad stuff in the atmosphere that we wouldn't want hanging around. We make sure that the winds are blowing away from populations towards the ocean."

Click on the picture above to see more pictures and video. ■

Above: Members of the launch weather team. Photo credit: NASA/Goddard/Laura Betz



CHOREOGRAPHED TO PERFECTION

By: Elizabeth M. Jarrell

Not all world-class choreographers design for principal dancers of the American Ballet Theater or the Marinsky Ballet, both known for extreme perfectionism; some, who are actually engineers, work with astronauts underwater to choreograph spacewalks.

"As we approach the 20th anniversary of the first Hubble Servicing Mission later this year, we need to tell our 'formula for success' story before it is forgotten," says Mike Weiss, then the deputy technical program manager for the Hubble Space Telescope and now the Laser Communications Relay Demonstration (LCRD) mission project manager, who was there from the beginning.

The stage was set when the Solar Maximum Mission (SolarMax), which launched on Feb. 14, 1980, to study the sun during high periods of the solar cycle, developed a malfunction. SolarMax blew a fuse. "The challenge was to figure out how to repair SolarMax using shuttle-based, space-walking astronauts to allow our scientists to observe the next period of solar maximum activity, which occurs only once every 11 years, without spending funds to design, build and launch a new solar observatory," explains Weiss. Engineers from Goddard met with their counterparts at Johnson Space Center to brainstorm.

Because movement under water is as close as possible to approaching that of zero-gravity, astronauts had long prepared for spacewalks in Johnson's Weightless Environmental Training Facility (WETF), the predecessor to today's Neutral Buoyancy Laboratory (NBL). The standard approach to problem-solving spacewalk issues was for the astronauts to don training versions of their spacesuits and dive into the pool with their scuba-diving assistants. Design engineers and other training assistants observed the training runs deckside. The astronauts trained for SolarMax repair by working with a mockup of the spacecraft.

"It just wasn't working efficiently," says Weiss. "The engineers felt too disconnected from the trainers. We couldn't get a feel for how things were really going underwater." Ken Rosette, a Goddard design engineer, came up with a brilliantly simple solution: The spacecraft engineers could learn to scuba dive so that they could work underwater next to the astronauts. The project manager, Frank Cepollina, endorsed the idea.

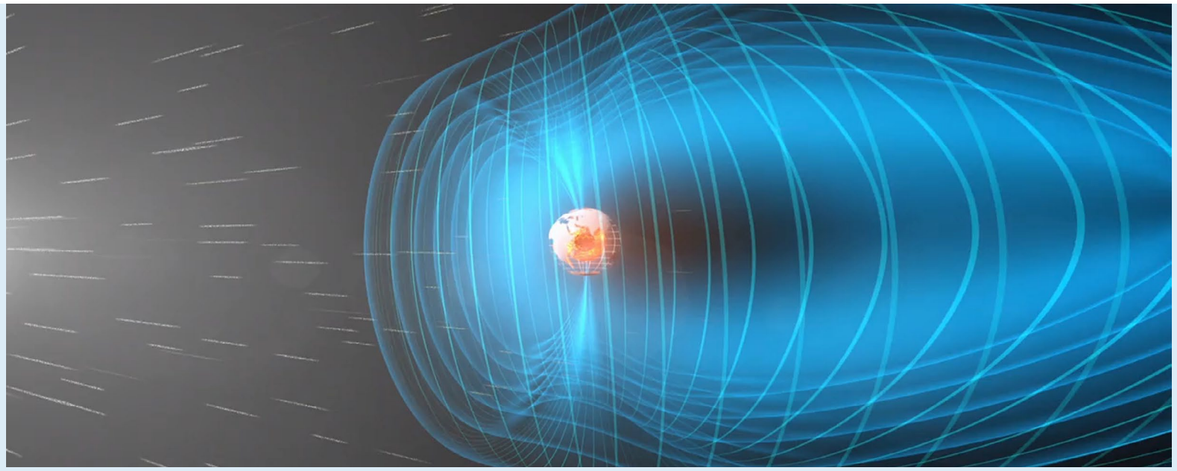
About a dozen engineers prepared for their new starring roles as scuba divers by becoming certified. Once in the water, they better understood how the tools and equipment they were designing for the complex spacecraft would operate in a zero-G environment. "Working in the water alongside the astronauts and being able to observe and assist with the underwater training made all the difference in quickly finding the correct solutions," says Weiss. It was the beginning of an incredible partnership between Goddard's spacecraft experts and Johnson's shuttle experts and astronauts.

On April 24, 1990, Hubble launched to be NASA's preeminent eyes in the sky. Then came major disappointment: Hubble couldn't focus. Hubble needed corrective glasses to correct flaws in the mirror design.

The scuba-diving engineers were again called in to rehearse with the astronauts. The life-size mockups of Hubble were large, so the underwater training began in Marshall Space Flight Center's Neutral Buoyancy Simulator (NBS), which was NASA's deepest tank. The team began preparing for a then unprecedented five spacewalks to repair an even more complicated spacecraft.

The servicing mission launched in December of 1993 and was an unqualified success. "Once the engineers learned how to scuba dive into the pool with the astronauts, the game changed," says Weiss. "SolarMax was the beginning, but Hubble really changed the game. Our work led not only to marvelous scientific discoveries, but it also definitively demonstrated NASA's ability to successfully perform on-orbit servicing missions." Scuba-diving engineers were later used to train for assembly of the International Space Station. They remain ready to help with future missions to take NASA even farther into space. ■

Above: Divers help astronauts prepare for spacewalks by working on a Hubble Space Telescope simulator in an underwater tank at Johnson Space Center. Photo credit: NASA



THE MYSTERIOUS MATH OF THE SOLAR WIND

By: Karen C. Fox

Many areas of scientific research—Earth's weather, ocean currents, the outpouring of magnetic energy from the sun—require mapping out the large scale features of a complex system and its intricate details simultaneously.

Describing such systems accurately relies on numerous kinds of input, beginning with observations of the system, incorporating mathematical equations to approximate those observations, running computer simulations to attempt to replicate observations, and cycling back through all the steps to refine and improve the models until they jibe with what's seen. The models successfully help scientists describe, and even predict, how the system works.

Understanding the sun and how the material and energy it sends out affects the solar system is crucial, since it creates a dynamic space weather system that can disrupt human technology in space such as communications and global positioning system satellites.

The sun and its prodigious stream of solar particles, called the solar wind, can be particularly tricky to model since as the material streams to the outer reaches of the solar system it carries along its own magnetic fields. The magnetic forces add an extra set of laws to incorporate when trying to determine what's governing the movement. Indeed, until now, equations for certain aspects of the solar wind have never been successfully devised to correlate to the observations seen by instruments in space. Now, for the first time, a scientist at Goddard has created a set of the necessary equations, published in *Physical Review Letters* on Dec. 4, 2012.

"Since the 1970s, scientists have known that movement in the solar wind often has the characteristics of a kind of wave called an Alfvén wave," says Aaron Roberts, a space scientist at Goddard. "Imagine you have a jump rope and you wiggle one end so that it sends waves down the rope. Alfvén waves are similar, but the moving rope is a magnetic field line itself."

The Alfvén waves in this case tended to have great consistency in height—or amplitude—but they are random in direction. You might think of it like a jump rope twirling, always the same distance from center, but nonetheless able to be in many places in space. Again, always the same distance from a given center, but with a variable placement.

Such metaphorical descriptions are based on what instruments in space have, in fact, observed when they see magnetic waves go by in the solar wind. But it turns out that the equations to describe this kind of movement—equations necessary to advance scientific models of the entire system—were not easily found.

"The puzzle has been to figure out why the amplitude is so constant," says Roberts. "But it's been very difficult to find equations that satisfy all the characteristics of the magnetic field."

Similar waves are seen in light, known as polarized waves. But magnetic fields have additional constraints on what shapes and configurations are even possible. Roberts found a way to overlap numerous waves of different wavelengths in such a way that they ultimately made the variation in amplitude as small as possible.

To his surprise, the equations Roberts devised matched what was observed more closely than he'd expected. Not only did the equations show waves of constant amplitude, but they also showed occasional random jumps and sharp changes—an unexplained feature seen in the observations themselves.

"Overlapping the waves in this way gives us a way of writing down equations that we didn't have before," says Roberts. "It also has this nice consequence that it is more realistic than we expected, since it shows discontinuities we actually see in the wind. This is important for simulations and models where we want to start with initial conditions that are as close to the observed solar wind as we can get."

Of course, having an equation doesn't yet tell us the reason why the waves in the solar wind are shaped in this way. Nonetheless, equations that describe how the waves move open the door to increasingly accurate simulations that may well help explain such causes. By alternately improving models and improving observations, scientists continue the cyclic nature of such research, until just what physical action on the sun causes these curiously-shaped Alfvén waves someday becomes clear. ■

Above: A constant stream of particles and electromagnetic waves streams from the sun toward Earth, which is surrounded by a protective bubble called the magnetosphere. Image credit: European Space Agency

GODDARD CELEBRATES MARTIN LUTHER KING, JR.

By: Claire Saravia

Goddard employees took a break from their daily work schedules on February 21 to celebrate the life and legacy of Dr. Martin Luther King, Jr.

Goddard's African American Advisory Committee organizes an event every year for employees to reflect on King's civil rights work and become motivated to continue his mission. This year, Goddard employees were inspired thanks to nationally-recognized political strategist and commentator Donna Brazile, who addressed the event's attendees as the keynote speaker.

As part of this year's "Be the Dream" theme, Brazile told employees that despite making great strides in ending racial segregation, there is still a lot of work Americans have left to do. "We're still at a crossroads," Brazile said. "After this speech, that should inspire you to get up tomorrow and do something else."

Brazile said since NASA employees promoted change through scientific discovery, they should also make an effort to be leaders in making changes that emphasize diversity. "You invest in the future and look beyond our planet to see what's out there and what's possible," Brazile said to the crowd.

Brazile's speech echoed the goals the event planning committee had when planning this year's event. African American Advisory Committee senior champion Dennis Andrucyk said this year's "Be the Dream" theme sent a powerful message to Goddard employees to be leaders in making changes, including opening an honest dialogue about race and creating efforts of their own. "The whole concept of 'Be the Dream' has to start someplace," Andrucyk said. "I encourage everyone at Goddard to think about what your dream is."

In addition to Brazile's speech, employees had other opportunities to be uplifted and inspired at this year's event. Children from Goddard's Child Development Center performed three songs honoring King and his "I Have a Dream" speech. Poet and activist Kavon Ward recited her poem "Pages From My Diary to Dr. King" and students from the Future Shock D.C. hip-hop dance troupe also performed.

Though committees on campus work to promote diversity throughout the Center every day, deputy director for technology and research investments Dr. Christyl Johnson said it was important to hold the event as a reminder of King's dream and his work to make it a reality.

"The Goddard community holds this annual event to celebrate Martin Luther King's life and reflect on the many ways his deeds and words influence our lives," Johnson said.

Brazile told employees that the event's theme should not only remind them to recognize King's dream, but be sure they spread that dream and strive to fulfill it. "'Be the Dream' is to believe that dream is still relevant in 2013," Brazile said. "We're the generation who must keep his work, keep his dream, alive." ■

Photo credit: NASA/Goddard/Bill Hrybyk

OUTSIDE GODDARD

By: Elizabeth M. Jarrell

NOTEWORTHY VIDEO GAMES

Web editor Rob Garner spends his work days hovering over a keyboard. But it's keys of a different type that occupy his off-hours. Garner is a musician in the Gamer Symphony Orchestra (GSO) at the University of Maryland.

"GSO is the very first college orchestra to draw its repertoire entirely from the sound tracks of video games," Garner says. "By taking these songs and putting them in a concert hall, we hope to bring new audiences to orchestral music and to video games. We tend to think this music is great, even if you've never touched a game controller."

Garner's musical career began in the fourth grade when he decided to learn trumpet. "I didn't like math, and music was an occasional free pass because it met at the same time," he says. "I picked trumpet because it was small and only had three buttons to worry about."

Garner kept up with the horn through college. GSO's founder recruited Garner in late 2005. Back then, the group was brand new. There were less than a dozen members and the group had yet to rehearse, let alone perform in public.

"I saw a chance to couple music performance with a childhood love of Nintendo® games, so I jumped on board," Garner says. To resolve an overcrowding problem in the trumpet section, Garner switched to flugelhorn, a cross between the trumpet and the French horn, in the fall of 2007. He ran GSO's administration as a graduate student and now serves as the group's president emeritus.

GSO today consists of 120 people, 80 in the orchestra and 40 in the chorus. Rehearsals are once a week and the ensemble gives one concert each semester. "We don't want cost to be a barrier," Garner says, so the shows are always free. Students manage all aspects of the ensemble, he says, including conducting and sheet music production. "There aren't a lot of game scores available for purchase, so members listen to the music and transcribe parts for GSO by ear." Garner notes that the process "gives the music our own style."

He finds it remarkable how dedicated everyone is to GSO, given that members receive neither payment nor academic credit for their efforts. "In a lot of cases people sacrifice their time and money to participate," he says. "But the music and the people mean so much to us that we're more than happy to do it."

"We're not just about performing," Garner says. "We also want to make sure that the people in GSO are enjoying themselves. For us, it's not just about our performances, it's about our community." Garner adds with a smile, "Some of us love GSO so much that we start relationships within it." Garner met his fiancée, a violinist, in the ensemble.

The greater community of video game music fans is paying attention, too. GSO shows routinely fill the largest concert hall on the university's campus. Some area high schools have even founded orchestras in GSO's image.

The professional Video Games Live touring concert series took interest in the college musicians, and the two groups worked together to add some GSO pieces to the tour in 2011 and 2012. "Video Games Live was one of the sources of inspiration behind our founding, so to get that level of recognition from them was simply amazing," Garner says.

GSO capped off its 2012 season with a spring concert at the Smithsonian American Art Museum in Washington, D.C. "The museum invited us to perform as part of their 'Art of Video Games' exhibit," Garner says. "Our whole purpose is to show that video games have legitimate artistry. It's immensely satisfying to see that idea gaining ground." ■

Below: Garner demonstrates the flugelhorn.

Below left: The Gamer Symphony Orchestra during one of its concerts. Photo credit: Edward Campion